

Introduction to Observing System Simulation Experiment (OSSEs)

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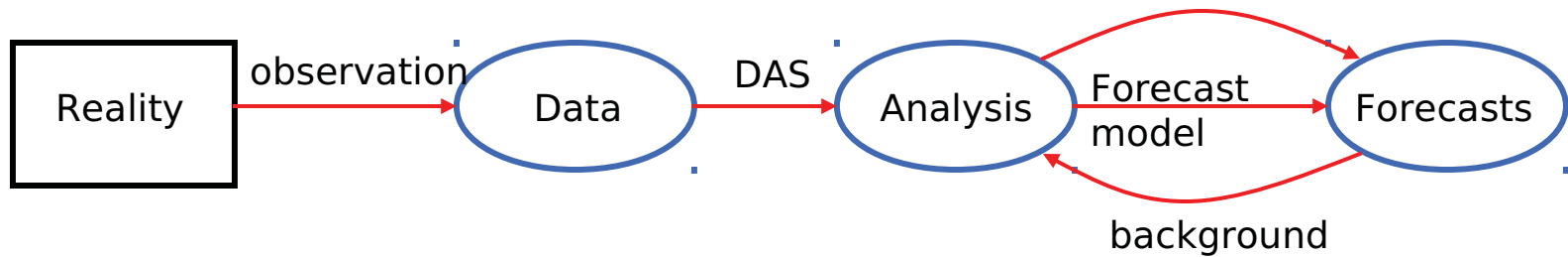
What is an OSSE?

An OSSE is a modeling experiment used to evaluate the impact of new observing systems on operational forecasts when actual observational data is not available.

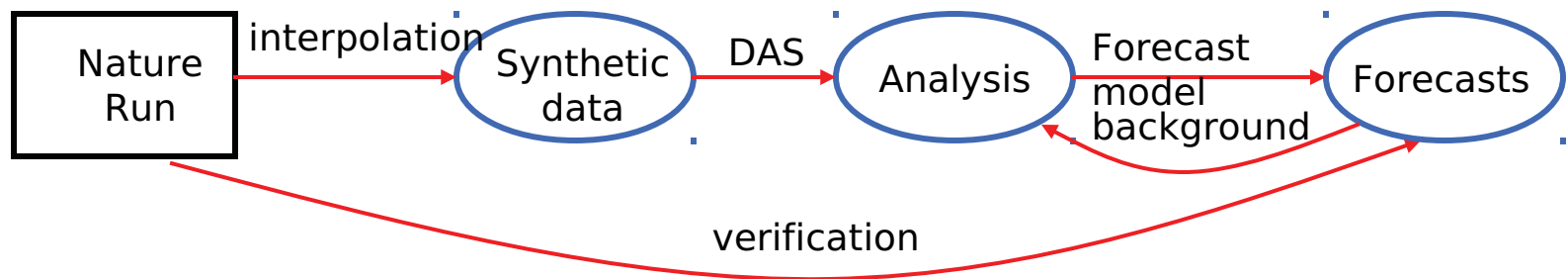
- A long free model run is used as the “truth” - the Nature Run
- The Nature Run fields are used to back out “synthetic observations” from all current and new observing systems.
- The synthetic observations are assimilated into a different operational model
- Forecasts are made with the second model and compared with the Nature Run to quantify improvements due to the new observing system

OSSEs vs. the Real World

Real world forecasts



OSSE forecasts



Nature Run Requirements

- Nature Run will act as the ‘truth’
 - Advantage: we know everything
- Must be able to realistically model phenomena of interest
 - Dynamics and physics should be realistic
 - Must produce fields needed for “observations”
 - Should be verified against real world
- Usually a ‘free’ run of a numerical weather model
- Ideally is ‘better’ than operational forecast model

Synthetic Observations

- Want to replicate **all** observational types used operationally
- Also need to make observations for new data types
- Interpolation from Nature Run fields to mimic spatial and temporal distribution of real observations
- Add errors to make observations less perfect

Forecast Model Requirements

- Data Assimilation System must be able to ingest both current and new data types
- Forecast model ideally similar to an operational model
- Forecast model should be distinctly different from the model used to make the Nature Run
 - ‘identical twin’ cases use the same model
 - ‘fraternal twin’ cases use similar models

Experiments

- Experiments are conducted similarly to OSEs, but with new data added instead of removed
- Choice of metric is important for designing experiments and interpreting results
- May need to run multi-month tests to see statistically significant results

Regional OSSE

- Much harder, more effort than global OSSE
- Need two Nature Runs – regional Nature Run embedded in global Nature Run
- Need to embed a second regional forecast model in a global OSSE to perform experiments
- Boundary conditions complicate all aspects
- Very rarely performed in full – major shortcuts are common

But can you trust it?

- Because every aspect of the OSSE is modeled, verification and calibration of the entire system is needed
- Run forecast model with real data and then again with OSSE system, compare results
 - Forecast skills
 - Observation impacts (OSE, adjoints)
 - DAS statistics (analysis increments, O-F, etc)

When to do an OSSE

- New observations are likely to be ingested into operational forecast models
- Real observations are unavailable or prohibitively difficult/expensive
- Questions about instrument design and/or deployment

When NOT to do an OSSE

- Real data is already available – do an OSE
- Models cannot replicate phenomena of interest
- Data assimilation cannot ingest the new observations

Pitfalls and Caveats

- OSSEs are not inexpensive
- Long lead times between OSSE and implementation – lots of changes to the model skill and observational network
- Beware of shortcuts
 - Omission of competing obs types from OSSE
 - Twin experiments